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<p>(54) Title: CARRIAGE DRIVE FOR A FOOD SLICER</p> <div data-bbox="487 1134 1153 1701"> </div> <p>(57) Abstract</p> <p>A carriage drive for a food slicer. The carriage can be adjusted from a manual operation to an automatic motor-driven operation. In order to set the slicer at automatic operation, the slicer includes a carrier which reciprocates on a slide rod. When a transport portion of the carriage supporting arm is attached to the carrier, then the carriage is driven by the motor. The motor is connected to the carrier through a series of four linkages which provide smooth motion, high drive efficiency and high reliability.</p>		

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CARRIAGE DRIVE FOR A FOOD SLICER

This application claims priority based upon provisional application No. 60/048617, filed June 4, 1997, entitled CARRIAGE DRIVE FOR A FOOD SLICER, attorney docket no. 006593-1645-P, in the name of Xie et al.

BACKGROUND OF THE INVENTION

The present invention relates to a carriage drive for a food slicer, and more particularly, this invention relates to a carriage drive which can be switched from manual to automatic operation and to an arrangement of mechanical linkages which connect the motor to the carriage and provide smooth motion, high drive efficiency and high reliability.

Slicing machines have been commercially available for many years. Typical food slicers have a rotatable, disc-like slicing blade and use a gravity feed to keep the food product in contact with the slicing blade. In such an arrangement, the rotating slicing blade is supported for rotation about an axis which is oriented in a plane extending at an angle to vertical, such as an angle of about 45 degrees. The slicers also generally include a gauge plate associated with the knife for determining the thickness of the slice and a carriage for supporting the food as it is moved past the cutting edge of the knife during slicing.

The food product-supporting carriage is mounted in a position generally perpendicular to the slicing plane and supports the food product as it reciprocates on a linear path past the cutting edge of the knife. As the carriage is withdrawn on its return stroke from the blade, the food product slides down the inclined carriage surface by the force of gravity and into contact with the

gauge plate. As the carriage is moved on its forward or slicing stroke, the food product will engage the knife and a slice will be removed, with the thickness of the slice being determined by the position of the gauge plate with respect to the knife.

Slicers of this type may be operated either manually or automatically. When using an automatic control, a specific number of slices may be produced in a slicing operation, thereby adding convenience for the user and minimizing food product wastage. To enhance productivity, the slicer may also be able to control the carriage stroke length as well as the carriage speed.

A conventional motor-driven carriage uses belt pulleys and an intermediate drive. A disadvantage of such prior systems is that they are inefficient, and unreliable, and the motion of the carriage past the cutting blade is sometimes not smooth and produces a jerk as the carriage changes directions.

Other prior art slicers include a carriage drive having a simple crank-slider drive mechanism. Under this arrangement, the carriage drive coefficient is very high, but only in the no load position. The transmission angle at peak load position (i.e., when the carriage is in the middle position and maximum output is required) is small and the carriage thereby requires a high peak driving force.

Therefore, these known systems may have low drive efficiency, poorly-designed slider mounting position, and do not produce smooth reciprocation of the carriage. Particularly, it is important to keep the drive force requirement low so that not as much power or as big a motor is needed.

Accordingly, there is a need for a carriage drive for a food slicer that will reduce the amount of jerk, reduce the needed drive force, and improve drive efficiency.

SUMMARY OF THE INVENTION

The present invention is a carriage drive for a food slicer which has a high drive efficiency, low peak drive force requirement, and reduces the amount of jerk. In a preferred embodiment of the invention, the carriage drive includes a slicer housing and a carriage reciprocally mounted to the housing, a slide rod mounted to the slicer housing, and a carrier reciprocally mounted on the slide rod for driving the carriage, the carrier having a cutout for attachment to the carriage. The carriage drive also includes a carriage reciprocally mounted to the housing, the carriage having a coupling member which is shaped to be received in the cutout of the carrier such that when the coupling member is linked to the carrier, the food slicer is capable of automatic reciprocation and when the coupling member is not linked to the carrier, the food slicer is manually operable.

Preferably, the carriage drive provides for engagement and disengagement of the power source by rotation of the slide rod which rotates the carrier so that the cutout is out of alignment with the coupling member. In addition, the slicer may be equipped with sensors for determining the carriage location so that a home start and a home return feature may be utilized.

The carriage drive of the present invention further preferably includes a set of four linkages for connecting the motor to the reciprocating carrier. The first linkage is less than 2 inches and connects the motor output to a second linkage. The second linkage connects the first linkage to an end portion of a third linkage. The third linkage connects the housing to a

fourth linkage and the fourth linkage connects the third linkage to the reciprocating unit. Mechanical linkage designs should meet several criteria. First, they should act together to provide a high drive efficiency. A high drive efficiency is achieved when the transmission angle is close to 90 degrees. As shown in Fig. 4, the first transmission angle α_1 is the angle between the links a_3 and a_4 . This approaches 90° as the link arm a_2 rotates around the motor output. The second transmission angle α_2 is the complementary angle between the link a_6 and rod a_7 . A high drive efficiency reduces the system load and increases system reliability.

The drive linkages should also assure that the jerk as the carriage changes directions is reduced for a smooth output of the system. The amount of jerk is related to the rate of change of the acceleration. The speed of the carriage (in strokes per minute, or motor's RPM) and the jerk of the carriage have a third power relationship, i.e., if the speed increases 46% from 35 strokes/minute to 51 strokes/minute, then the jerk will increase 209%. $[(51/35)^3 - 1] \times 100\% = 209\%$

In a preferred embodiment, the carriage drive further includes an adjustable member which is threadably received on the carrier and is capable of adjusting the position of the carrier with respect to the drive linkages. The adjustable member is connected to the linkages and does not rotate with the carrier.

It is a further object of the invention to provide a method of using the carriage drive for a food slicer carriage. The method includes providing a carriage which is transported in a reciprocating linear path on a transport, the transport having a coupling member; and providing a slicer housing including a motor, a slide rod, a carrier slidably mounted to the slide rod and a plurality of linkages connecting the carrier to the

motor. The carrier has a receptacle shaped to receive the coupling member. Then the slide rod and the carrier are rotated such that the receptacle is in alignment with the linear path of the coupling member; and the carriage and the coupling member are moved along the linear path such that the coupling member couples with the carrier, thereby connecting the carriage to the motor for motor driven operation of the carriage.

The objects and advantages of the present invention will be apparent from the following description, the accompanying drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front elevational view of a food slicer incorporating the carriage drive of the present invention;

Fig. 2 is a side view of the system of Fig. 1;

Fig. 3 is a bottom view of the system of Fig. 1;

Fig. 4 shows linkage parameters, kinetics and force analysis of the system of Fig. 3; and

Fig. 5 is an exploded view of the adjustment member.

DETAILED DESCRIPTION

As shown in Figs. 1 and 2, a food product slicer generally designated 10 in accordance with the present invention includes a housing 12 and a circular, motor-driven slicing blade 14 which is rotatably mounted to the housing on a fixed axis shaft 15. The food product is supported on a carriage 16 which moves the food product to be sliced past the rotating slicing blade. The carriage reciprocates in a linear path in a

direction parallel to the blade, and can be powered either automatically or manually.

This slicer can also be used in conjunction with a scale and can include an automatic stop when the scale reaches a preset weight or number of slices have been cut.

The carriage 16 is mounted on a carriage arm 18 which orients the carriage at the appropriate angle (typically perpendicular) to the slicing blade. The carriage arm 18 is supported on a transport 20. The transport has a mounting slot 22 to receive the foot 23 of the carriage arm 18. The transport has a width slightly larger than the foot 23 of the carriage arm 18. Transport 20 reciprocates in a slot 24 within the housing 12. The transport 20 has a through hole 26 on the end opposite the carriage arm mounting slot 22. The through hole 26 attaches the transport 20 to a transverse bar 28 and associated bearings 30. The transport 20 reciprocates along transverse bar 28.

The food slicer 10 also includes a slide rod 32 mounted on either end to the housing 12. The slide rod extends almost the entire length or width of the slicer, parallel to the transverse bar 28. The slide rod 32 is stationary. Preferably, it is substantially cylindrical having a generally circular cross-section with a flat side 34. Although the transverse bar 28 is described herein as having a circular cross section and slide rod 32 is described as having a substantially circular cross-section having a flat side, one skilled in the art will appreciate that the bars 28, 32 can have any cross section which facilitates operation of the slicing machine of this invention. For example, the slide rod could utilize a keyway in place of the flat side.

As shown in Fig. 2, a carrier 36 is reciprocally mounted on the slide rod 32. The carrier is shaped to slide easily along the slide rod 32. If the slide rod 32 has a flat side 34, then the carrier 36 may be adapted to include a plate 37 which is mounted to the front of the carrier and fits to the flat portion 34 of the slide rod so that the carrier does not rotate during its traversal of the rod. The carrier 36 may be made of metal and the plate 37 made of plastic. The carrier also may be made of plastic with an integrally molded side to fit the flat side of the slide rod.

The carrier 36 has a raised central portion 40 to which a ramp 42 is attached on the upper end thereof. The ramp 42 may be fastened to the carrier or it may be formed integrally with the carrier. The ramp 42 includes a cutout notch 44 therein and both sides 46, 48 of the ramp are inclined upwardly toward the cutout 44.

As shown in Fig. 1, the transport 20 includes a coupling member such as pawl 50 at the lower end thereof. The pawl is mounted to the transport by a pin 52. The pawl 50 is spring-actuated by means of a spring 53 which is housed in the transport and reacts against the pawl. The pawl is shaped to fit within the notch 44 in the ramp 42 portion of the carrier. Thereby, when the transport 20 is moved toward the carrier 36, the pawl 50 will ride up the ramp 46 or 48 and click into place in the notch 44, by means of the spring 53. The linear movement of the carriage 16 is now dependent upon the movement of the carrier 36.

The carrier 36 is attached to a motor 54 by means of a series of linkages. After the pawl 50 is locked in place, the carriage 16 is thereby coupled to the motor 54 for automatic operation (i.e., the carriage is driven by the motor). The motor drives the carrier by means of the linkages as shown in Fig. 3. The carrier 36

moves the transport 20 and the transport moves the carriage 16. In contrast, when the pawl 50 is not engaged in the cutout 44, the carriage can be moved manually.

To disengage the pawl for manual operation, a lever 56 shown in Fig. 2 is used. The lever 56 is coupled to slide rod 32 such that rotation of the lever 56, causes the slide rod to rotate. As the slide rod rotates, the carrier 36 rotates along with the slide rod, due to the fact that it is rotatably fixed by means of the flat plate 37. After the carrier rotates, the ramp 42 is no longer facing upwards toward the transport, but rotated to the side and the carrier is disengaged from the pawl. Thereby when the carrier is in this position, the transport may be freely moved manually back and forth, and the pawl 50 does not contact the cutout 44 in the ramp 42. The carriage of the slicer can thus be operated manually without interference from the drive mechanism. When the operator desires to return to automatic motion, the lever 56 is turned so that the slide rod 32 rotates the carrier 36 to its upright position. Then, the operator may manually reciprocate the carriage until the pawl 50 on the transport 20 rides up the ramp 42 and is fixed to the carrier.

The carrier 36 also includes an adjustable member 38 which due to its attachment to the linkage, establishes the point for the carrier to stop and change directions. The member 38 is attached to the carrier and reciprocates along with the carrier on the slide rod 32.

The adjustable member 38 as shown in the exploded view of Fig. 5 is shaped similar to a looking glass. It has a ring-shaped upper portion 90 through which the slide rod 32 passes. The bottom stick portion 92 extends downward toward the ground. The lowermost portion has a retaining ring 93 which connects the

adjustable member 38 to the mechanical linkages. The adjustable member 38 does not rotate with the carrier or the slide rod. It stays in an upright position since it is fixed to the linkages below.

The carrier 36 has an external thread on the end thereof which supports the adjustable member 38. An adjustable member support 94 having internal threads is threaded onto the carrier along with a nut 96. The adjustable member is thereby rotatively supported on the threaded adjustable support. By loosening the associated nut 96, the support 94 is free to rotate along the threads of the carrier which effectively lengthens or shortens the length of the carrier and causes adjustment to be made axially. The adjustable support can be moved relative to the carrier 36 to the desired position. Once the desired location is determined so that the cutout in the carrier is in the correct position to receive the pawl 50 and traverse the length of the slide rod, the nut 96 is tightened up against the adjustable member support thereby fixing the position of the member 38 on the carrier. The adjustable support is designed such that once the nut 96 and support 94 are clamped down on the carrier, they rotate with respect to the looking glass piece 38 when the slide rod is rotated. The piece 38 remains stationary during rotation of the slide rod since it is connected to the linkages by the retaining ring 93. This is set before operation of the slicer.

The knife motor should be operating before the lever 56 is turned or the motor for the automatic carriage operation will not start. Also, carriage arm 18 must be in the "home" position in order for the motor to start. The home position is the start position, all the way to one end of the slide rod usually closest to the operator.

The slicer is preferably equipped with two special features called "home start" and "home return." Home start insures that when in automatic mode, the motor will not start until the carrier (and thus the carriage) is in the home position. Therefore, if the carriage stops and it is not returned to the start position, it needs to be manually pulled back to that position before it can begin automatic operation again. This feature prevents the slicer from starting in mid stroke. If the slicing stroke started when the food product was in front of the blade, it would not produce a clean first stroke.

Home return means that the carriage will automatically return to its "home" or start position after the carriage reciprocation is stopped, i.e., the slicing operation is complete and the motor is off. Previously when the operator wished to terminate the slicing process, the operator switched the power switch to the off position, thereby terminating the power to the slicer motor. Once the power was terminated the carriage continued to coast along its reciprocal linear path until it came to rest in an arbitrary location. If the carriage came to rest in a position where the blade was embedded in the food product, a partial slice would be left dangling which is unattractive and may cause the partial slice to become wasted if it is left exposed to open air for too long. Further, it is convenient to replace the food product when the carriage is at the home position. Therefore, by using the home return feature, the carriage will be in the correct position to begin slicing so that the carriage does not need to be manually moved to the home position. Also, if a heating lamp is used to keep the food product warm, home return will ensure that the food product is properly positioned under the warming lamp.

The home return works in the following manner, the slicer is equipped with two sensors, a slice sensor

57 and a home sensor 58. The sensors are laterally spaced along a line parallel to the slicing direction. The slice sensor is a reed switch which is located on the base adjacent to the carriage. It is located such that it closes when the carriage is at a point wherein the front edge of the product being sliced is just past the knife blade. The magnet for the reed switch is located on the carriage. The home sensor is a reed switch located adjacent to the carriage such that it closes when the carriage reaches the front-most position. The switch utilizes the same magnet as the slice sensor. When the user presses the start/stop button, the system will wait until the carriage has passed the slice sensor 57. The next time the carriage passes the home sensor 58, the carriage motor is turned off by removing the power. The timing on the turnoff may be varied to accommodate the home switch position.

On some slicers, when the preselected weight of the sliced product or a preselected count has been reached, the unit will return home and stop in the same manner. That is, after the last slice desired has been cut, the next time the carriage reaches the home sensor, the controls will turn off the carriage motor.

The adjustable member 38 described above allows the manufacturer of the slicer to adjust the position of the carrier in its home position so that it is at the furthest extension on the slide rod (i.e., so that the carriage can have a full range of motion and be able to reach the carrier when the user desires to switch to automatic mode.)

The time ratio of the system, which is the ratio of the forward stroke to the return stroke, should be equal to or greater than one. This means that the forward stroke should take equal or longer time than the back stroke. The time ratio is controlled by length

ratios of the drive linkages. The peak load should be near the half stroke position; that is, half way between the forward most position of the carriage toward the blade, and the rear most position (i.e., home position) of the carriage, toward the user. The peak load depends on the location of the last linkage (link 82 in Fig. 3) to the carriage, as well as the type of linkages used. A good location of linkages reduces friction, which in turn reduces the input horse power requirement and wear of the parts. The linkage design should also have nearly 90° transmission angle at the peak load position. In addition, for proper runability of the slicer, the motor selection should take into account the peak load, average load, and controller effect. This is necessary to ensure reliability and prevent overheating problems.

In the automatic mode the motor 54 drives the carriage through the drive linkages which connect the motor to the carrier 36. The drive shown in Fig. 3 has been found to be an effective drive linkage. This system uses a set of four linkages connected to the output 55 of the motor 54 on one end and to the adjustable member 38 of the carrier 36 on the other. A right-angle gear motor and mechanical linkage have been shown to be a cost effective and highly reliable technology for automatic slicers. This system provides a smooth movement and reduces the jerk of the carrier as it changes direction. Dynamic analyses have shown that the slicer, as shown in the Figures, is preferably operated with a peak horse power of 0.11 HP. A 1/8 HP motor may be used to provide this horsepower. The motor is preferably a variable speed motor and the slicer includes a knob to adjust the speed. The right-angled gear motor is oriented so that the output shaft 55 extends vertically toward the ground and perpendicular to the slide rod 32.

The first linkage 60 is attached on its first end 62 to the output shaft 55 of the motor 54 and on its

other end 64 to a second linkage 66. A stud 68 connects the first linkage 60 to the second linkage 66 so that they can easily pivot with respect to one another. Preferably the pin 68 is integral with the link 60 and fits within a hole in the second link 66.

The second linkage 66 is connected on one end 69 to the first linkage 60 and on its second end 70 to a third linkage 72. It is attached to the third linkage at a location approximately $3/8$ down the length of the third linkage by means of another stud 74 which is attached in a similar manner as described above.

The third linkage 72 is connected on one end 76 to a flange 78 on the housing 12 and on its other end 80 to the end of the fourth linkage 82. The third linkage is connected to the flange to establish a fixed pivot point. The flange position is a factor of space availability, as room must be left in the base for the motor, electronics of an associated scale, etc. The fourth linkage 82 is connected on one end 84 to the end of the third linkage 80 and on its other end 86, to the carrier 36.

A suitable range of length of the first link 60 (a_2) as shown in Fig. 4, is nearly 5 cm, which can vary depending on the space availability. The length ratios between the linkages are as follows: Where a_1 is the distance from the flange 78 to the motor shaft; a_2 is the length of the first link 60; a_3 is the length of the second link 66 or coupling rod; a_4 is the distance from the flange 78 to pivot point 74 along link 72; a_5 is the distance from flange 78 to the end of link 72; a_6 is the length of the link 82; and a_7 represents the slide rod 32. The preferred ratios are as follows.

$$a_1/a_2=5.849$$

$$a_3/a_2=5.695$$

$$a_4/a_2=1.667$$

$$a_5/a_2=5.128$$

$$a_6/a_2=3.594$$

This linkage design provides maximum driving force at the proper position, near the half-stroke. It reduces friction and the requisite horse power.

These length ratios are optimized with respect to the size of a particular machine. The length of the linkages can be changed and the system will still be optimized if the same ratios are used. Further, the ratios can be varied slightly without deviating from the scope of the invention.

Having described the invention in detail and by reference to preferred embodiments thereof, it will be apparent that modifications and variations are possible without departing from the scope of the invention defined in the appended claims.

What is claimed is:

1. A carriage drive for a food slicer comprising:
 - a slicer housing;
 - a motor mounted in said housing;
 - a slide rod mounted to and traversing said slicer housing;
 - a carrier reciprocally mounted on said slide rod, said carrier being drivingly connected to said motor and having a cutout therein;
 - a transport including a coupling member shaped to be received in said cutout of said carrier; and
 - a carriage for supporting a food product mounted to said transport;such that when said coupling member is received in said carrier, said carriage and transport reciprocate along with said carrier and are capable of being driven by said motor and when said coupling member is not coupled with said carrier, said transport is capable of movement independent of said carrier to enable manual operation,
 - and wherein said carrier is capable of rotation to move said cutout in and out of alignment with said coupling member.
2. The carriage drive of claim 1 wherein said carrier includes a ramp and said cutout is a notch in said ramp.
3. The carriage drive of claim 2 wherein said transport holds said carriage and is capable of transporting it along a linear path parallel to said slide rod and wherein said coupling member is a spring-loaded pawl which is attached to said transport and shaped to be received in said cutout.
4. The carriage drive of claim 2 wherein said ramp is secured to said carrier.

5. The carriage drive of claim 2 wherein said ramp is integral with said carrier.
6. The carriage drive of claim 1 wherein said slide rod is substantially cylindrical and has a flattened portion and said carrier is shaped to receive said flattened portion such that rotation of said slide rod causes rotation of said carrier.
7. The carriage drive of claim 1 further comprising a lever connected to said slide rod such that movement of said lever causes rotation of said slide rod.
8. The carriage drive of claim 1 further comprising at least two sensors laterally spaced on said slicer housing, said sensors detecting the position of said transport.
9. The carriage drive of claim 8 further comprising home start such that said motor will not start until said sensor detects that said carriage is in a correct position.
10. The carriage drive of claim 8 further comprising home return such that said carriage returns to a starting position after said motor has turned off.
11. A carriage drive for a food slicer comprising:
 - a slicer housing;
 - a motor having an output and being mounted in said housing;
 - a reciprocating carrier which drives an associated carriage;
 - a set of four linkages connecting said motor to said reciprocating carrier wherein,
 - a first linkage of said set is connected on one end to an output of said motor and to a second linkage of

said set on an opposite end thereof, said first linkage being less than 2 inches in length;

said second linkage is connected on one end to said first linkage and on an opposite end to a third linkage of said set, said third linkage having a first end and a second end such that said second linkage is connected at a predetermined distance from said first end of said third linkage;

said third linkage is connected to said housing on said first end and to a fourth linkage of said set on said second end; and

said fourth linkage is connected to said third linkage on one end and to said reciprocating unit on an opposite end.

12. The carriage drive of claim 11 wherein said second linkage is connected to said third linkage approximately one-third of its length from said first end.

13. The carriage drive of claim 11 wherein said motor is an right-angle gear motor.

14. The carriage drive of claim 11 wherein the length ratios between the linkages are approximately as follows:

$$a_1/a_2=5.849$$

$$a_3/a_2=5.695$$

$$a_4/a_2=1.667$$

$$a_5/a_2=5.128$$

$$a_6/a_2=3.594$$

where a_1 is the length of the flange to the motor shaft, a_2 is the length of the motor output shaft to first link 60, a_3 is the length of the second link 66 or coupling rod, a_4 is the length from the flange 78 to pivot point 74 along link 72; a_5 is the length from flange 78 to the end of length 72; and a_6 is the length of the link 82.

15. The carriage drive of claim 11 further comprising an adjustment member attached to said carrier and to said set of four linkages such that said motor is capable of driving said carrier through said linkages.

16. The carriage drive of claim 15 wherein said carriage is externally threaded on one end and further comprising an adjustable member support which is threaded onto said carrier and supports said adjustable member such that said carrier and adjustable member support can rotate with respect to said adjustment member.

17. The carriage drive of claim 16 wherein said adjustable member support is threaded on said carriage until said carrier is at a desired position with respect to said linkages and is fixed by means of a nut.

18. A method of using a carriage drive to adjust a food slicer carriage from a manual to an automatic motor-driven operation comprising the steps of:

- providing a carriage which is transported in a reciprocating linear path on a transport, said transport having a coupling member;

- providing a slicer housing including a motor, a slide rod, a carrier slidably mounted to said slide rod and a plurality of linkages connecting said carrier to said motor, said carrier having a cutout shaped to receive said coupling member;

- rotating said slide rod such that said carrier rotates and said cutout is aligned with said linear path of said coupling member; and

- moving said carriage and said coupling member along said linear path such that said coupling member couples with said carrier, thereby connecting said carriage to said motor for motor driven operation of said carriage.

19. The method of claim 18 wherein said slide rod has a substantially circular cross-section including a flat

side and said carrier is shaped to fit said flat side such that the step of rotating said slide rod rotates said carrier.

20. The method of claim 18 further comprising a lever attached to said slicer housing such that the step of actuating said lever, rotates said slide rod.

21. The method of claim 18 further comprising providing an adjustment member and the step of threading said adjustment member on said carrier such that said carrier is located at a correct position relative to said slide rod.

22. The method of claim 18 further comprising providing a home sensor and a slice sensor laterally spaced on said housing, such that said slicer will not start until said home sensor detects said carriage.

23. The method of claim 22 comprising the steps of:
turning off said slicer such that said carriage passes said slice sensor and the next time it reaches said home sensor, said motor is shut off.

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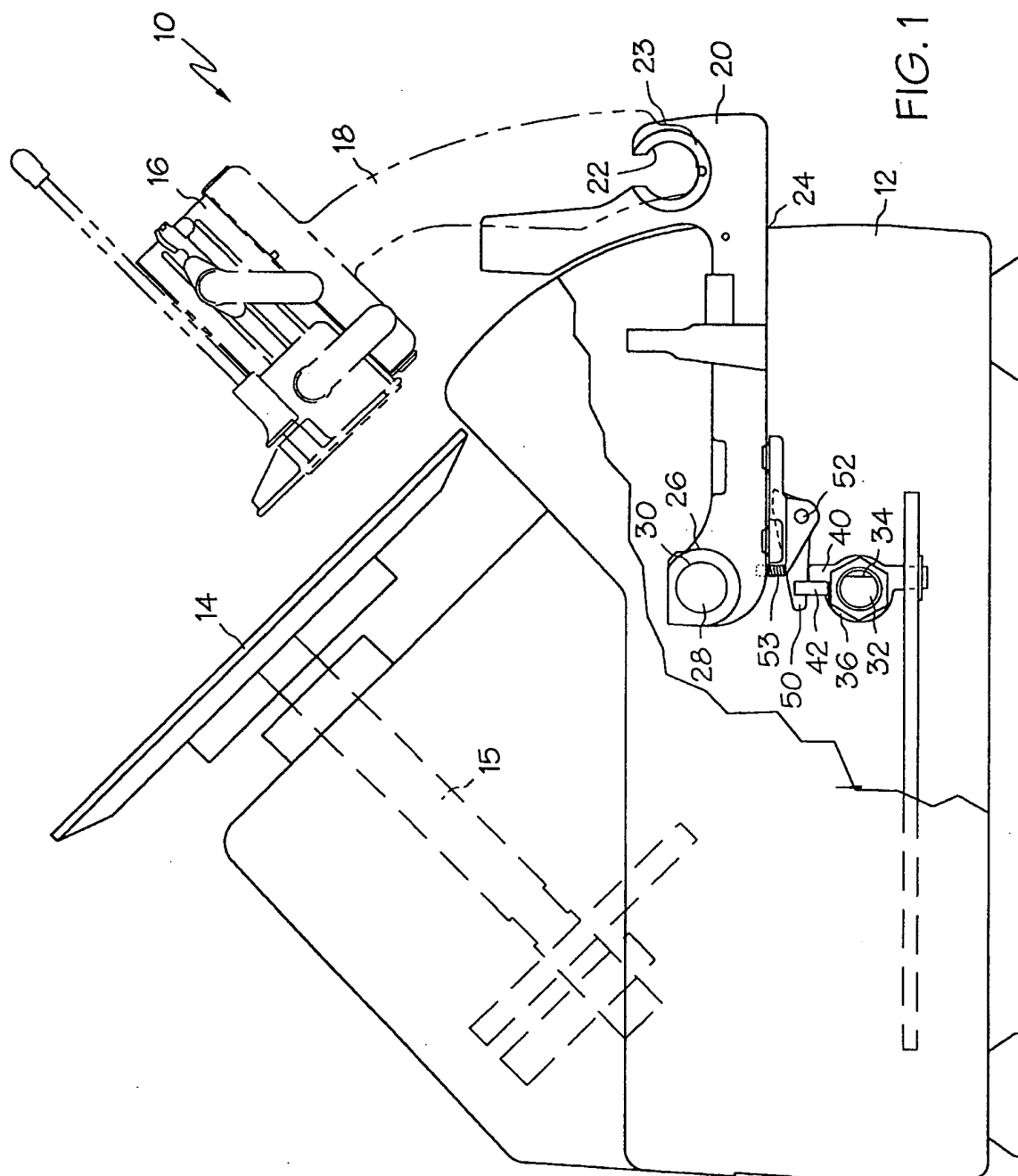


FIG. 1

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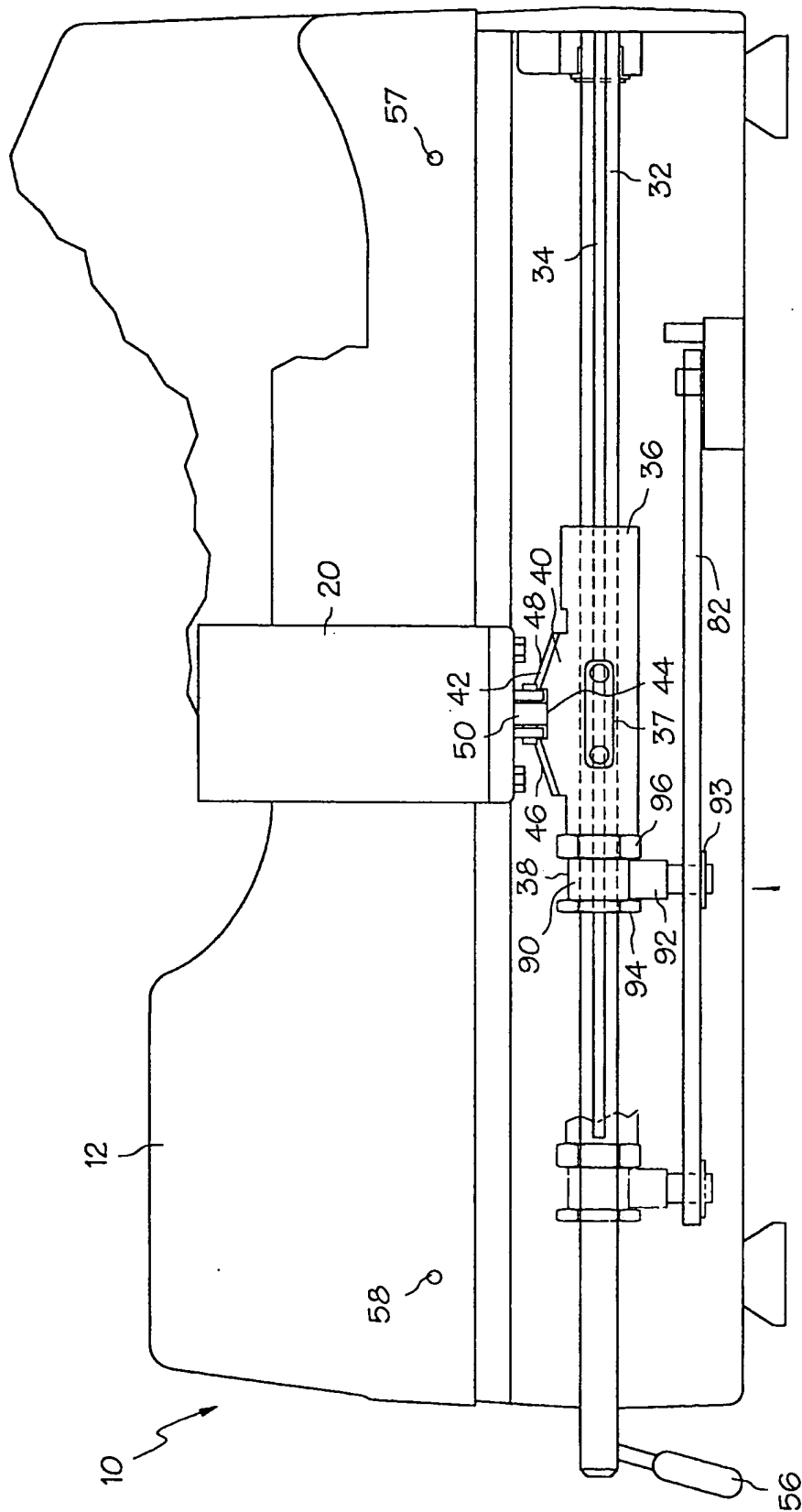


FIG. 2

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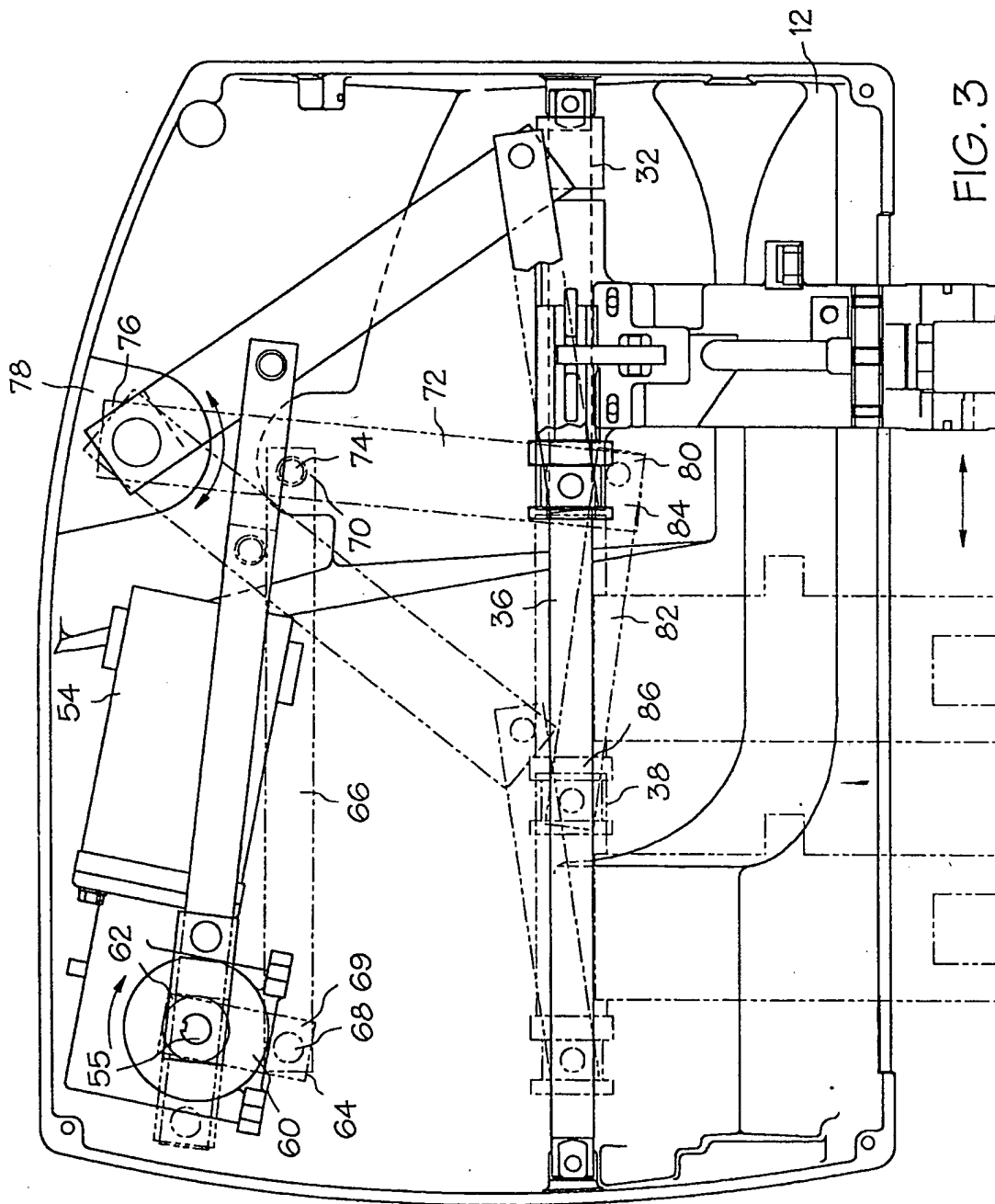


FIG. 3

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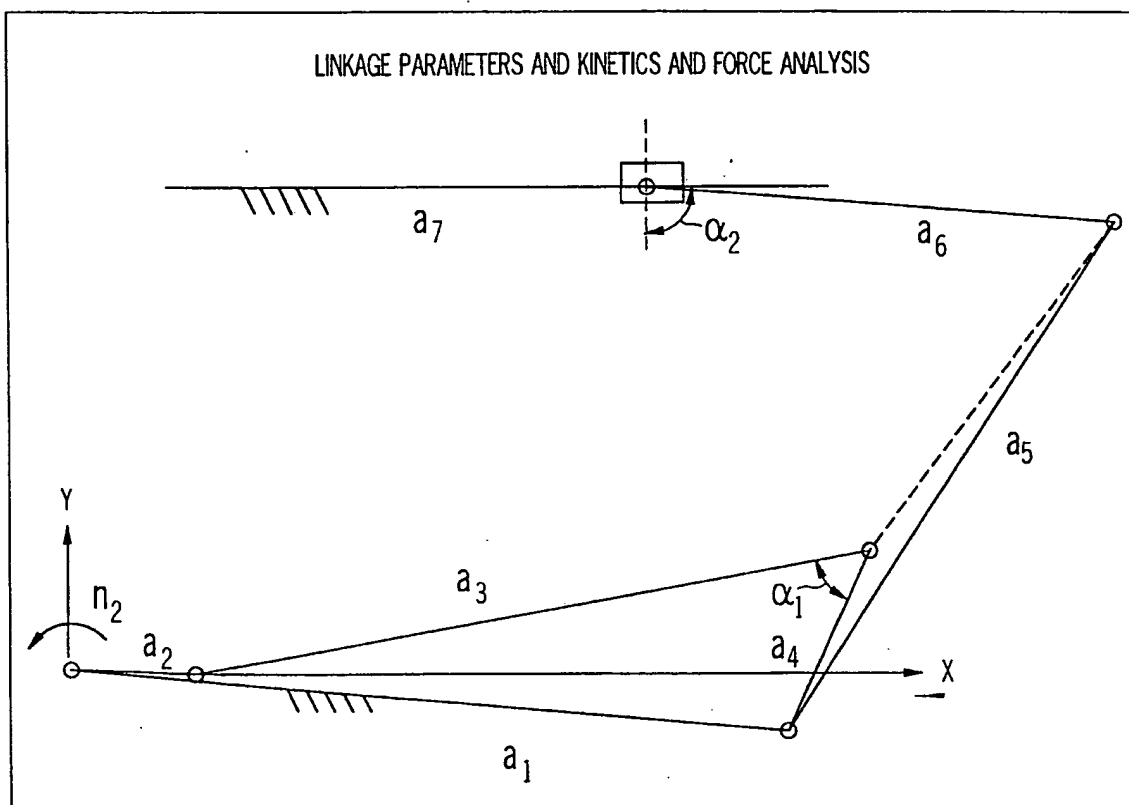


FIG. 4

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